Space Weather Technical Forecast

Issued on Wednesday, 26 July 2023 at 13:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: CME arrived 25 Jul, with G1/Minor storms likely 26 Jul. R1/R2 blackouts likely 26 Jul with a chance throughout.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Moderate with two M-flares and 11 sunspot regions. Peak flare was an M4.6 from AR3376 at 26/1037 UTC with a further M1.4 flare from this region at 26/0428 UTC. This is an evolving and compact region in the northwest, which is becoming difficult to analyse but is increasing in activity. The remaining regions remained stable or decayed slightly.
No Earth-directed CMEs were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: CME arrival occurred at L1 at 24/2153 UTC with solar winds speeds at L1, increasing from background values of around 370-390km/s to average between 475-540 km/s following a peak of 560 km/s. Density also rose from background levels to above average at 15 ppcc, but have steadily declined back to average values.. Interplanetary magnetic field (IMF), Bt, was initially weak and steady at 5-7 nT but rose to peak near 17nT at 24/2156 UTC, before fitfully easing to weak levels. The north-south component was variable ranging from +6 to -6nT, but dropped to -12nT with the CME arrival, before quickly becoming positive, peaking 15nT. A turbulent variation then occurred between north and south, although overall strength in the north-south direction decreased. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3), but with a G1/Minor Storm interval observed 25/2100-2400 UTC with the CME arrival. A further Active interval was observed 26/0300-0600 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux persisted around 1.5 to 2.5 pfu after the enhancement by the far-side event on 24 Jul, well below the S1 Minor Storm threshold, before falling nearer to background at 25/1730 UTC. GOES16 high energy (greater than 2MeV) electron flux was background to moderate throughout, with the associated 24-hour integrated fluence persisting below the Active threshold following a downward trend. Fluence was 5.82e6 total pfu at 25/2400 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Low to Moderate activity is expected, with further M-class flares likely.

Solar Wind / Geomagnetic Activity: CME arrival on 24/2153 UTC is potentially the very early arrival of a CME forecast to arrive later on 26 or 27 Jul, from a flare on 23 Jul. There are other potential sources of the enhancement observed however, and so a further arrival later 26 Jul or early 27 Jul cannot be completely ruled out. Otherwise a weak coronal hole high speed stream may arrive 28 Jul, however this is low confidence. Ongoing CME effects are likely to give Active to G1 Minor Storm intervals at first 26 Jul. Any further enhancement will give a chance of further G1 Minor Storms. As CME influence recedes, likely during 27 Jul, mainly Quiet to Unsettled conditions are expected, rising again to Unsettled to Active, with a slight chance of G1 Minor Storms with any coronal hole enhancement on 28 Jul.

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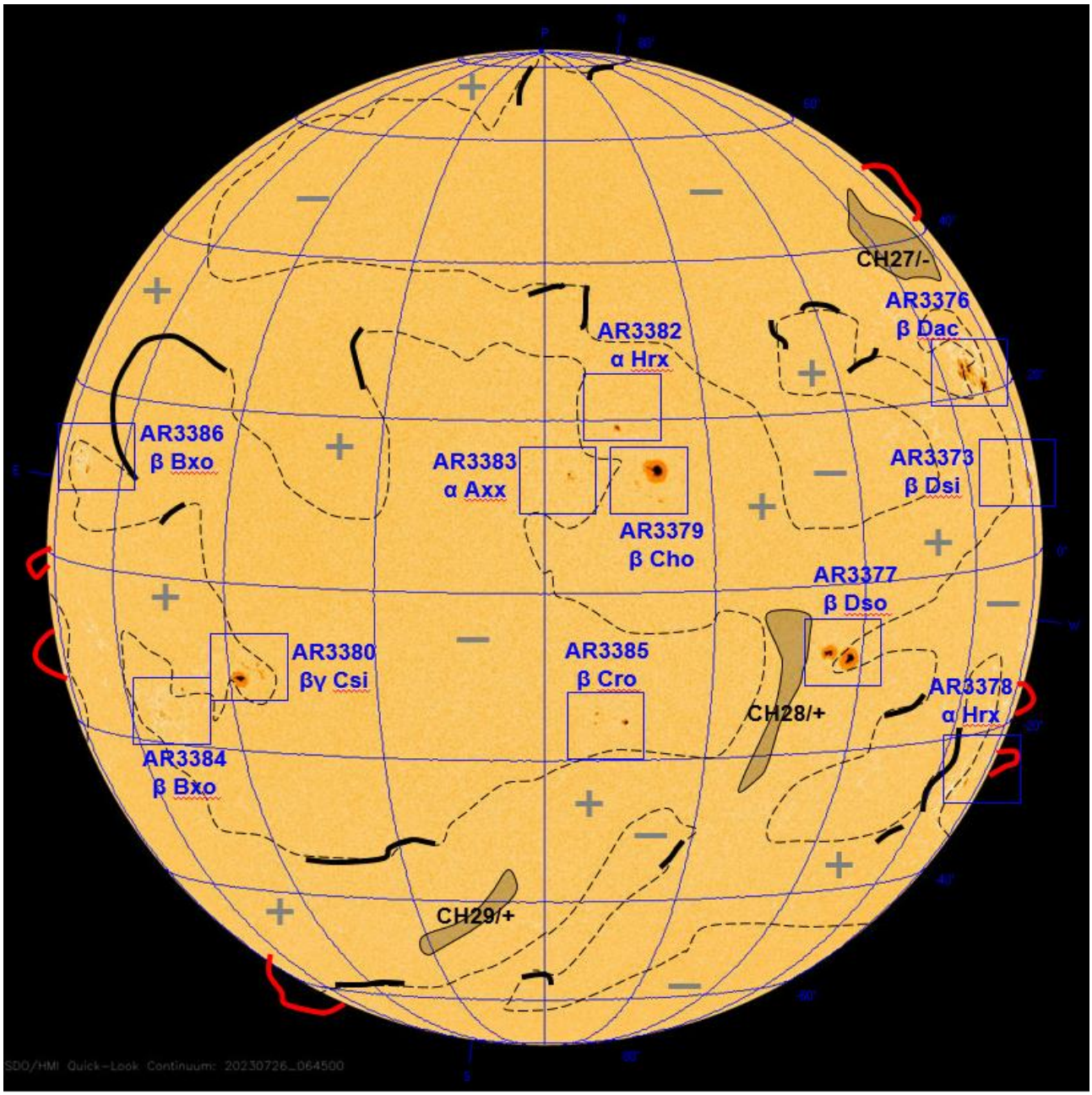
Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux is expected to continue declining towards background. There remains a slight chance of proton flux increasing from any further significant flares that occur. The high energy (greater than 2MeV) electron flux is expected to persist at mainly background levels, but with a chance of becoming more persistently moderate, perhaps rising to high once any CME influence recedes 27 Jul onward.

Figure 1. Solar Analysis Valid 26/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
A CME arrived at L1 at 25/2153 UTC which is potentially the early arrival if a CME which left the Sun on 23/1457 UTC. This was forecast to arrive either later 26 Jul or during 27 Jul, but the eruption was preceded by a large, broad shock. This shock may be what has arrived at Earth. Another less likely source could be a CME which left the Sun around 22 Jul and which was modelled to pass ahead of Earth. Due to the uncertainty in the forecast, the probabilities reflect the risk of a further CME arrival at Earth. Any CME impacts should then wane through 27 Jul.

A coronal hole high speed stream may then connect with Earth during 28 Jul, although this is a weak feature and any impacts are likely to be limited. Speeds are forecast to be in the range of 400-500km/s should it connect.

Ongoing CME effects on 26 Jul could lead to Active or G1/Minor Storm intervals. A decreasing risk of geomagnetic storming on 27 Jul with mainly Quiet to Unsettled conditions. The high speed stream connection is unlikely to produce significant impacts, with only Active intervals forecast.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	80	20	5	5
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: Recent solar wind parameters, with the CME shock clearly discernible

Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate with AR3376 in the northwest quadrant the most active region. This region has developed notably through the last 24 hours and has produced a recent M4.6 flare. This was one of two M-class flares from this region as it continues to develop. However this region is also becoming increasingly difficult to assess as it approaches the limb. AR3380 has also produced an M-class flare in the last 36 hours, but nothing in the last 24 hours. Overall there are 11 sunspot regions on the disc, with the remaining regions weak, benign or stable.

Moderate or Low activity is expected through the next 24 hours.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	40
Very Active	R3 to R5 X Class	No	10	10	5	5

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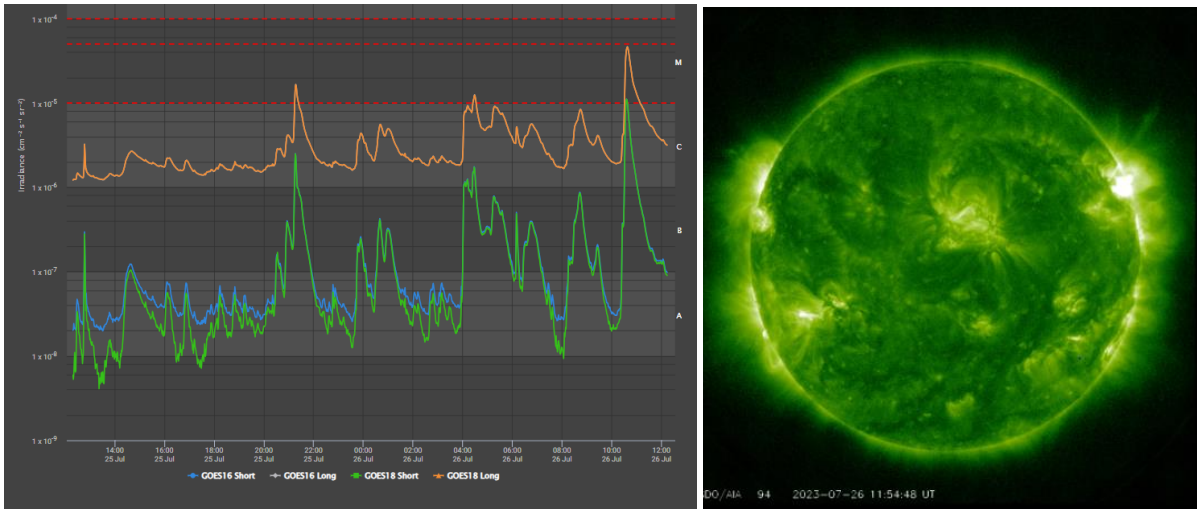
Figure 3: GOES 16 X-ray flux and an image of the flare from AR3376 on SDO AIA-94 imagery.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 became enhanced on 24 Jul, but below the S1 level, due to a large far-sided eruption, but have now declined to background. There is a slight chance of further enhancements given any large flares, primarily from AR3376 or any of the other regions on the western disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
High energy (greater than 2MeV) electrons started at moderate levels, but have been mainly background during the last 18 hours. The recent CME arrival may charge the electron belts sufficiently to allow the electron counts at GEO to reach moderate or high levels, but with solar wind high speeds and density, the belts are likely to be distorted from their natural position. Further charging could take place on 28 Jul due to the possible connection with the coronal hole high speed stream from coronal hole 28.

Electron fluence is following a downward trend and is likely to remain below the active (1e8 integrated pfu) threshold through 26 Jul, but with an increasing likelihood through the remainder of the period, as solar winds ease and the radiation belts relax into their natural orbits.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	20	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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